What is claimed is:

1. A waveguide photodetector system, comprising:

a multiple mode interference (MMI) cavity having an input end and an output end;

an input waveguide optically coupled to the MMI cavity at the input end; and

an array of detector waveguides optically coupled to the MMI cavity at the output end and each optically coupled to an intrinsic region surrounded by first and second electrodes.

2. The system of claim 1, wherein the input waveguide is single-mode.

3. The system of claim 2, wherein the MMI cavity produces N interference nodes at the output end, and wherein each detector waveguide is arranged at or near an interference node.

4. The system of claim 1, wherein the input waveguide, MMI cavity and detector waveguides comprise a material selected from the group of materials comprising: Si, Ge, Ge on Si, Ge_xSi_{1-x}, SiO_xN_y and Si_3N_4.

5. The system of claim 3, wherein the intrinsic region comprises silicon.

6. The system of claim 3, wherein the intrinsic region comprises germanium.

7. The system of claim 1, wherein the first and second electrodes associated with each of the intrinsic regions are connected in parallel.

8. The system of claim 7, further including:

an input device optically coupled to the first waveguide to provide an optical signal to be detected; and

an output device electrically coupled to the first and second electrodes so as to receive an outputted photocurrent.

9. The system of claim 8, wherein the input device includes a laser.

10. The system of claim 1, wherein the first and electrodes are respectively n+ doped and p+ doped silicon.

11. The system of claim 1, wherein the detector waveguides are coupled to the respective intrinsic regions by evanescent coupling.

12. The system of claim 1, wherein the intrinsic region has a carrier collection distance of less than 1 micron.

13. The system of claim 1, wherein each detector waveguide has a core with a core width, and wherein each intrinsic region has a carrier collection distance substantially equal to the core width.

14. The system of claim 1, wherein the detector waveguides are single mode.

15. The system of claim 1, wherein the system has a detection speed of 10 GHz or greater.

16. A method of generating an output photocurrent from a guided lightwave, comprising:

dispersing the guided lightwave into multiple (N) guided lightwave modes;

forming N interference nodes from the N guided lightwave modes;

coupling the light from the N interference nodes into corresponding N waveguides;

coupling the light traveling in each of the N waveguides to a corresponding intrinsic region in each of N PIN detectors to generate the output photocurrent.

17. The method of claim 16, including connecting the N PIN detectors in parallel.

18. The method of claim 16, wherein the coupling of light from the waveguides to the intrinsic regions is performed via evanescent coupling.

19. The method of claim 18, wherein each waveguide has a core with a width, and including forming the intrinsic region so as to have a width substantially the same as the waveguide core width.

20. The method of claim 19, wherein one or more of the waveguides are single mode.

21. The method of claim 20, including forming the PIN detector with self-aligned n+ and a p+ electrodes surrounding the intrinsic region.

22. The method of claim 21, wherein dispersing the guided lightwave is performed using a multiple-mode interference (MMI) cavity.

23. A method of forming a waveguide photodetector, comprising:

forming semiconductor islands from a semiconductor layer overlying an insulating layer of a substrate;

forming insulating regions between the semiconductor islands;

forming atop the semiconductor layer a first waveguide core, a multiple mode interference (MMI) cavity core adjacent the first waveguide core, and an array of second waveguide cores atop the islands and adjacent the MMI cavity;

forming for each second waveguide core a PIN detector having an intrinsic region adjacent a surface of the second waveguide; and

forming a cladding over the first waveguide core, the MMI cavity core and the array of second waveguide cores.

24. The method of claim 23, including forming the first waveguide core, the MMI core and the array of second waveguide cores by processing a layer of one of Si, Ge, Ge on Si, Ge_xSi_{1-x}, SiO_xN_y and Si_3N_4 formed atop the semiconductor layer.

25. The method of claim 23, wherein portions of the islands are doped to form n+ and p+ electrodes that surround the intrinsic region.

26. A method of processing an electrical signal, comprising:

converting the electrical signal to a guided wave optical signal representative of the electrical signal;

dispersing the guided wave optical signal into multiple (N) guided wave modes;

forming N interference nodes from the N guided wave modes;

coupling the light from the N interference nodes into corresponding N detector waveguides; and

coupling the light traveling in each of the N waveguides to a corresponding intrinsic region in each of N PIN detectors and generating an output photocurrent electrical signal representative of the guided wave optical signal.

27. The method of claim 26, wherein the electrical signal is a time-division multiplexed signal, and further including:

demultiplexing the output photocurrent electrical signal to form demultiplexed electrical signals.

28. The method of claim 27, including guiding the guided wave optical signal over a single-mode waveguide.

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29. The method of claim 28, wherein the single-mode waveguide comprises an optical fiber.

30. An optoelectronic system, comprising:

a waveguide photodetector including:

a multiple mode interference (MMI) cavity having an input end and an output end, an input waveguide optically coupled to the MMI cavity at the input end, an array of detector waveguides optically coupled to the MMI cavity at the output end and each optically coupled to an intrinsic region surrounded by first and second electrodes so as to detect photon-generated carriers formed in the intrinsic region and output a photocurrent;

an input device optically coupled to the input waveguide that generates an optical signal and inputs the optical signal into the input waveguide; and

an output device to receive the photocurrent.

31. The optoelectronic system of claim 30, wherein the input device includes one of a laser diode and vertical cavity surface emitting laser.

32. The optoelectronic system of claim 31, wherein and the output device includes a transimpedance amplifier.

33. An optoelectronic clocking system, comprising:

an input device that generates an optical signal;

an optical edge tree comprising a main waveguide optically coupled to the input device, and a plurality of equal-length waveguide branches extending from the main waveguide;

a waveguide photodetector coupled to each waveguide branch, each waveguide photodetector including:

a multiple mode interference (MMI) cavity having an input end and an output end, an input waveguide optically coupled to the MMI cavity at the input end, an array of detector waveguides optically coupled to the MMI cavity at the output end and each optically coupled to an intrinsic region surrounded by first and second electrodes so as to detect photon-generated carriers formed in the intrinsic region and output a photocurrent; and

a plurality of electronic edge trees comprising equal-length conductive branches, with each conductive branch coupled to one of the waveguide photodetectors to receive the photocurrent.

34. The optoelectronic clocking system of claim 32, wherein each electronic edge tree branch is connected to an output device.

35. The optoelectronic clocking system of claim 32, wherein the input device includes one of a laser diode and a vertical cavity surface emitting laser.